



Re-Birth

Childbirth simulation

A 3D Immersive Simulation for Education and Patient Engagement

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MiBirth & The Role of 3D Simulation

MiBirth is a research initiative that uses **prenatal MRI imaging** to create detailed **3D anatomical models** of the fetus, uterus, and birth canal.

These models help assess:

- Whether a fetus can pass safely through the birth canal
- **Potential complications** in delivery
- How to support more successful natural births

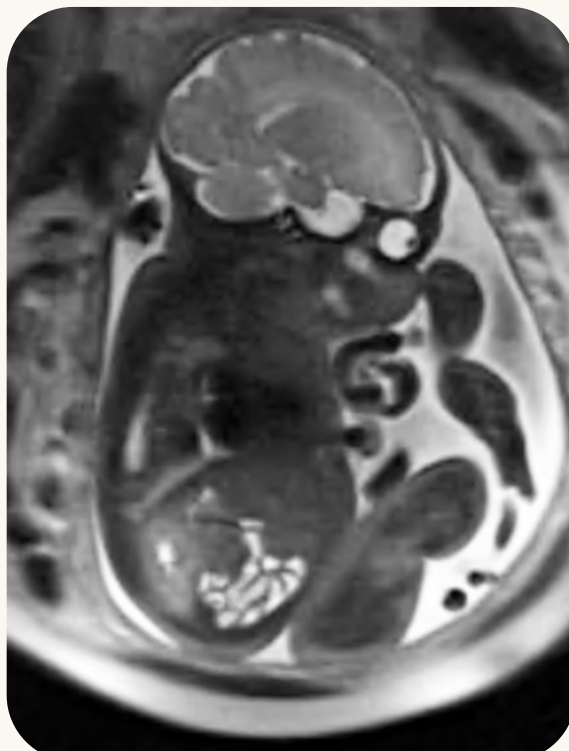
Our Role

Our team was tasked with **creating a sample patient-specific 3D simulation** that:

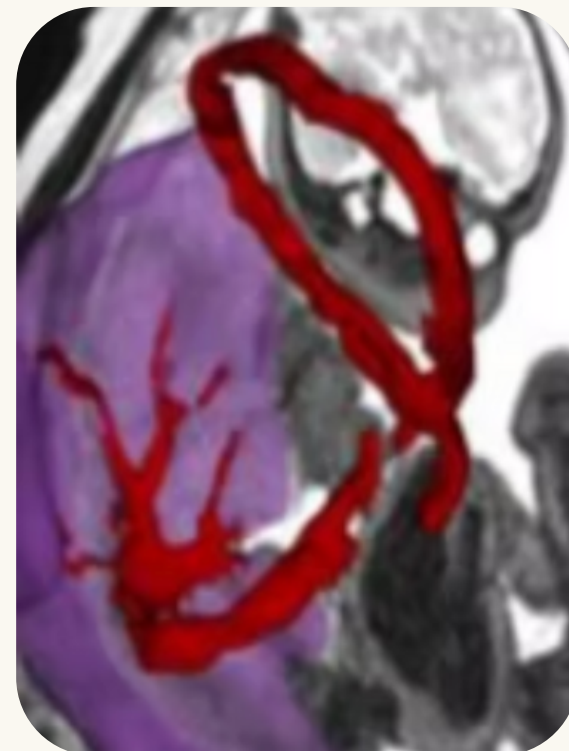
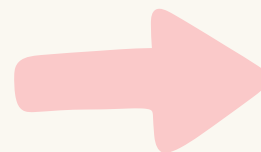
- Demonstrates what a full personalised simulation could look like
- **Uses segmented data** (fetus, placenta, cord) to animate childbirth
- Can be adapted for other patients enrolled in the MiBirth program

Current Solution:

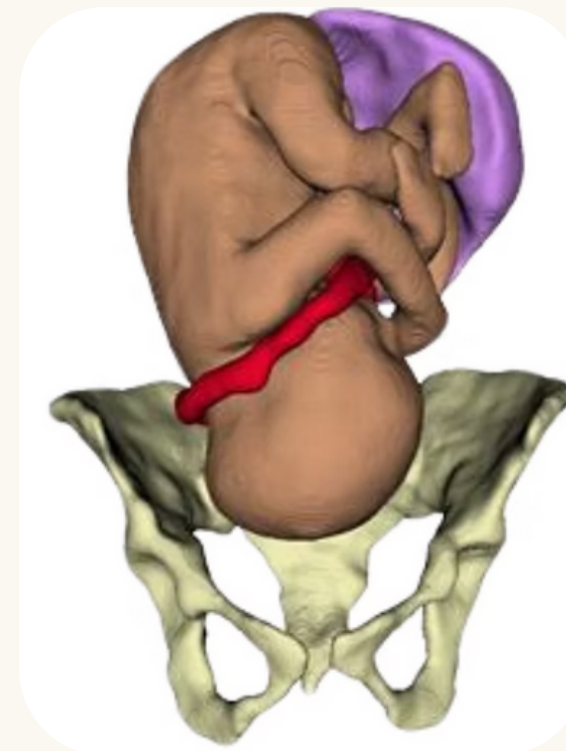
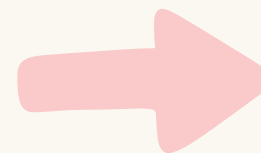
mi3irth



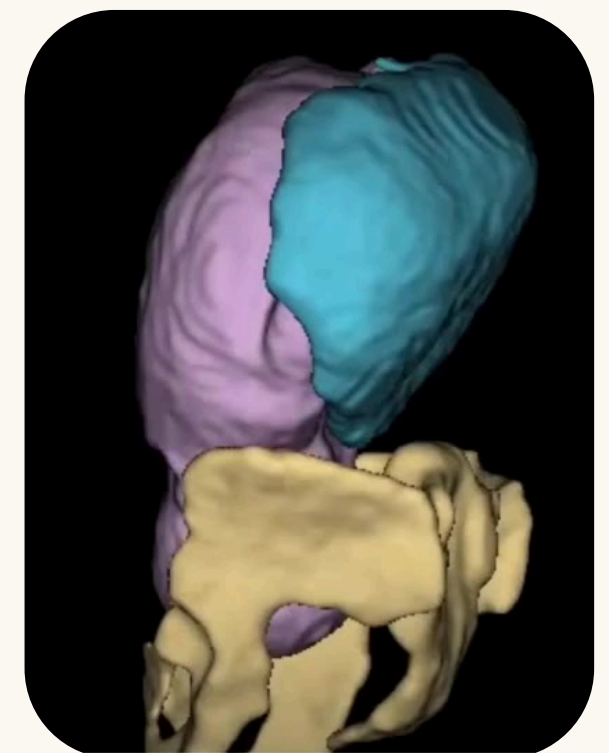
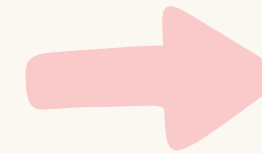
Prenatal MRI image



Segmentation



3D- segmented models



Simple Animation

Blender vs Unity



Blender

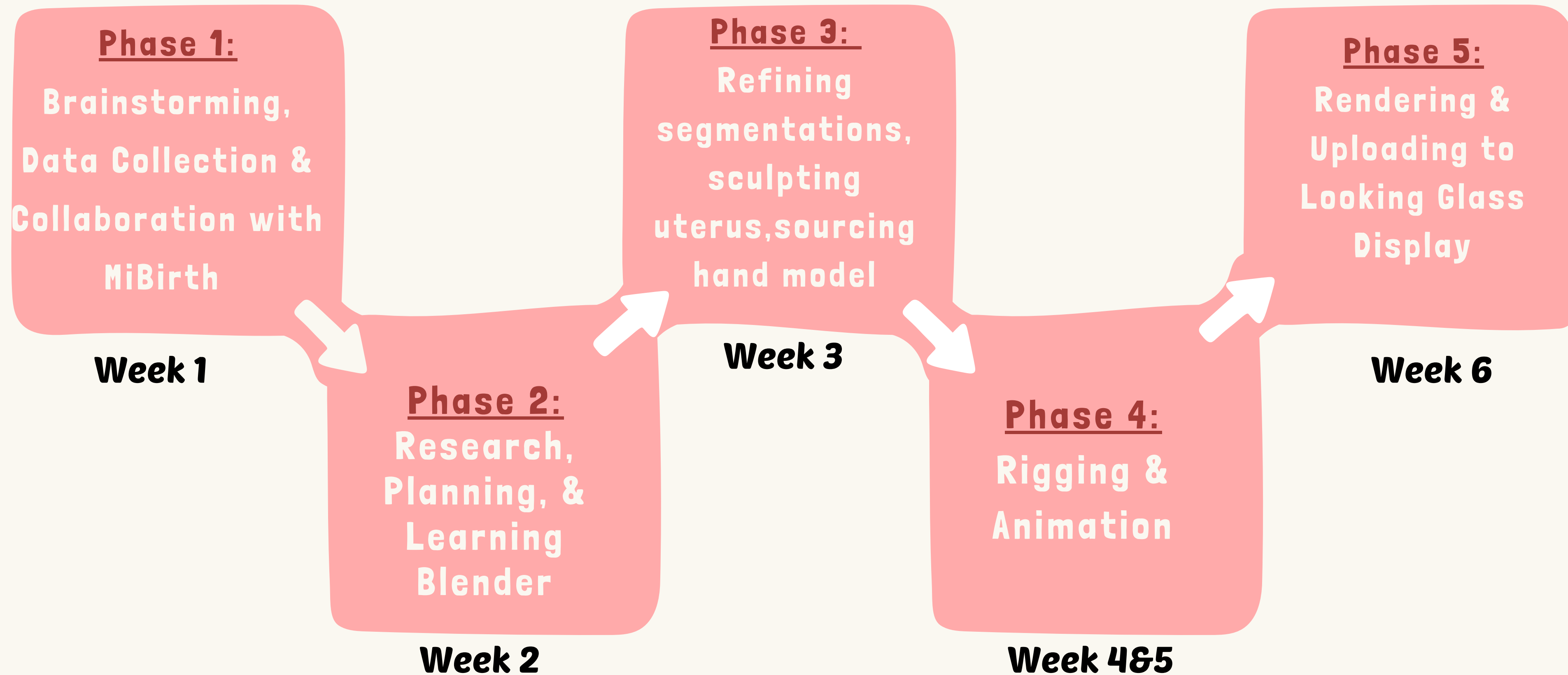
- More related to what our aim was: 3D simulation
- Requires less computational power
- Better rigging and rendering tools for accurate material representation.
- Sculpting features

Unity

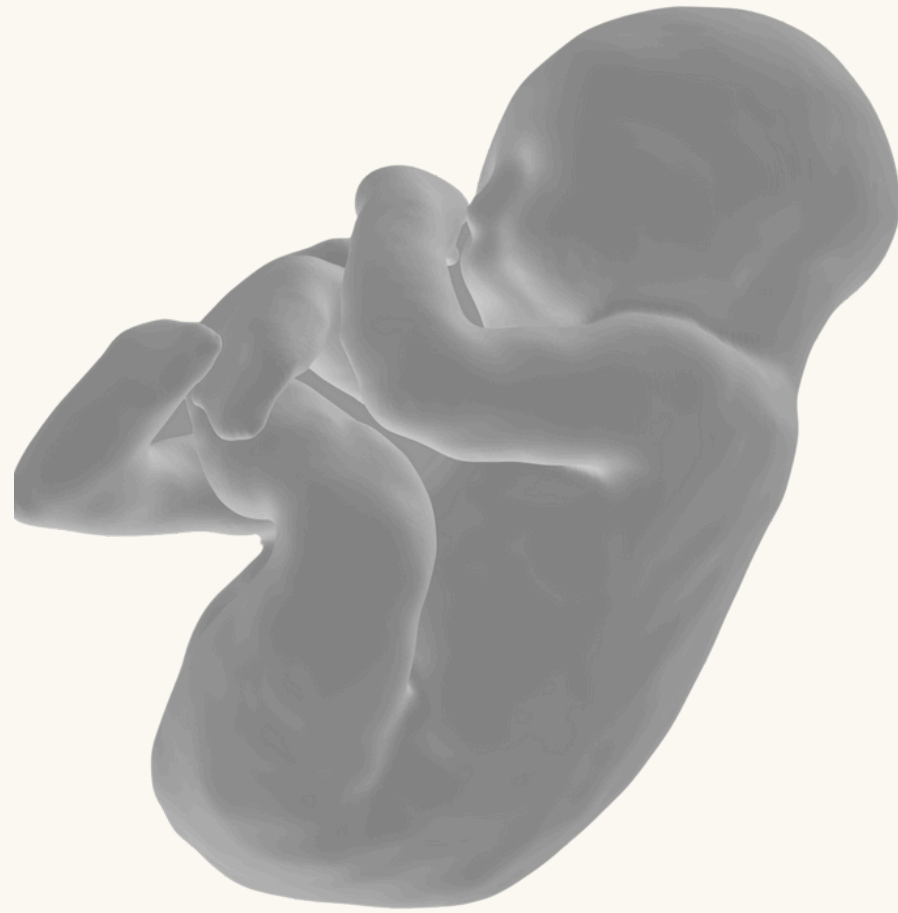
- Used for VR application
- More computational power
- Specialised in real-time rendering, sacrificing visual fidelity
- Requires many 3rd party plugins



Project Framework



Phase 1: Segmentation



Fetus

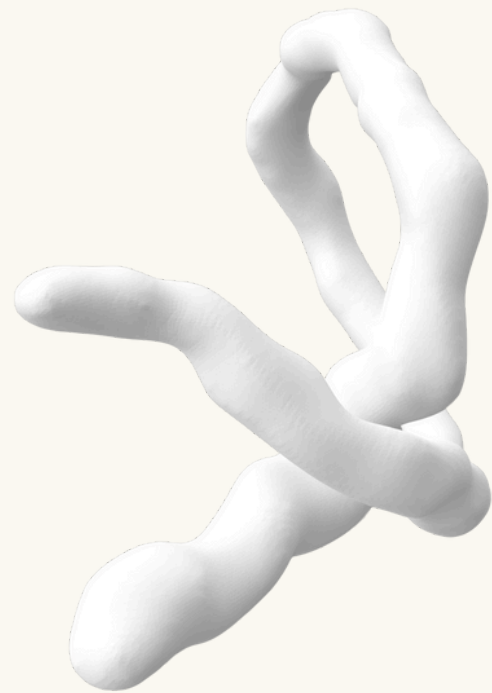


Placenta

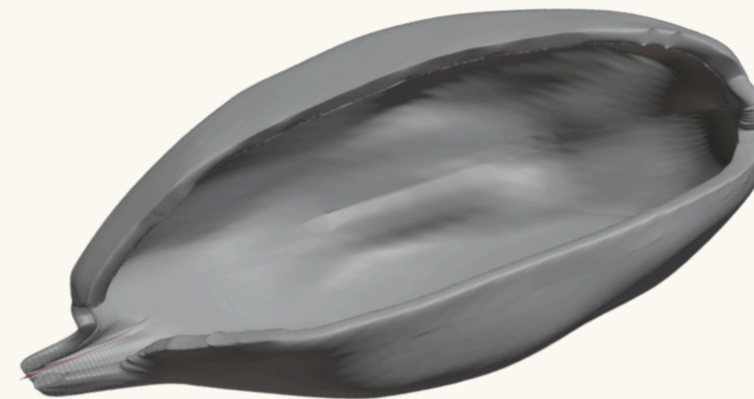


Pelvis

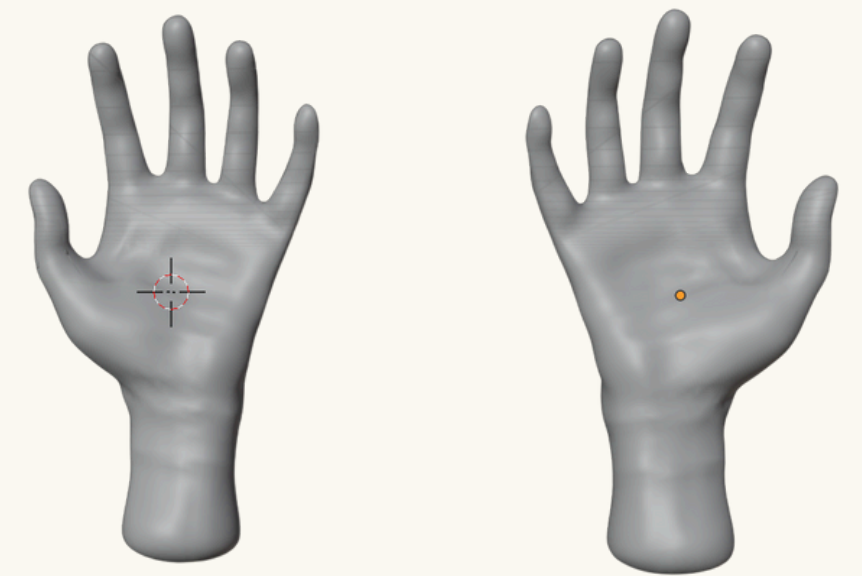
- The **MiBirth** team provided the **fetus**, **placenta**, **pelvis** and **umbilical cord** segmentations from MRI images.
- The **uterus** was modelled on blender .
- A **pre-made** model was used for the doctor's hands



Umbilical cord



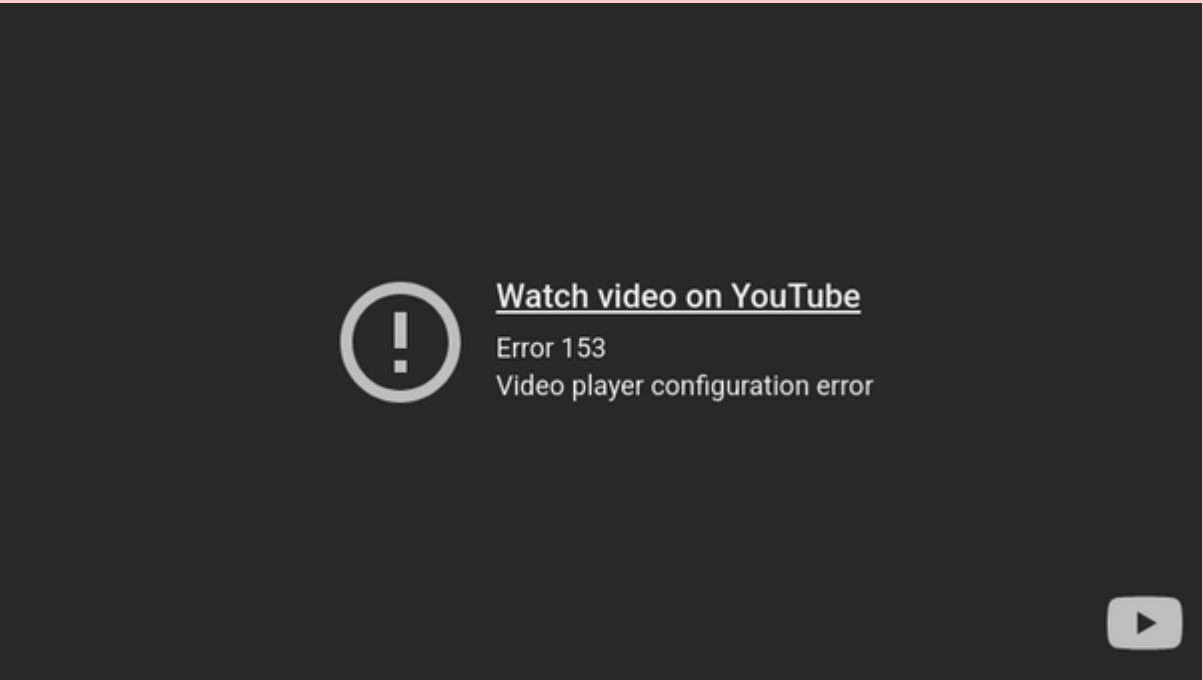
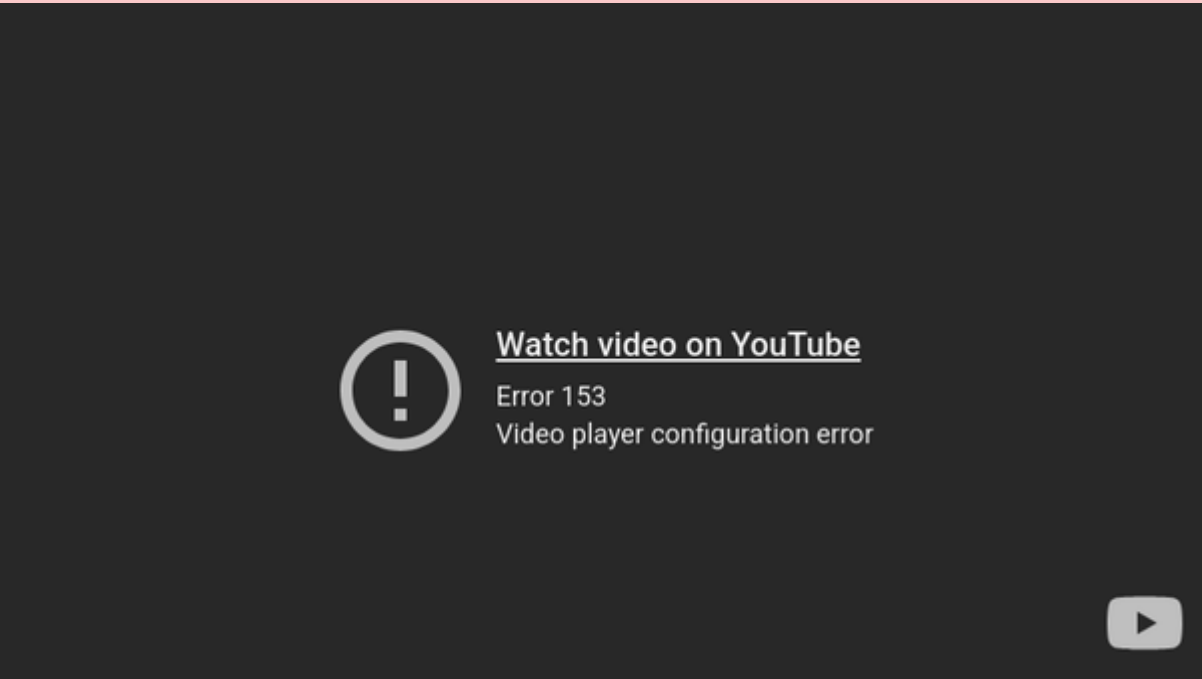
Gravid Uterus



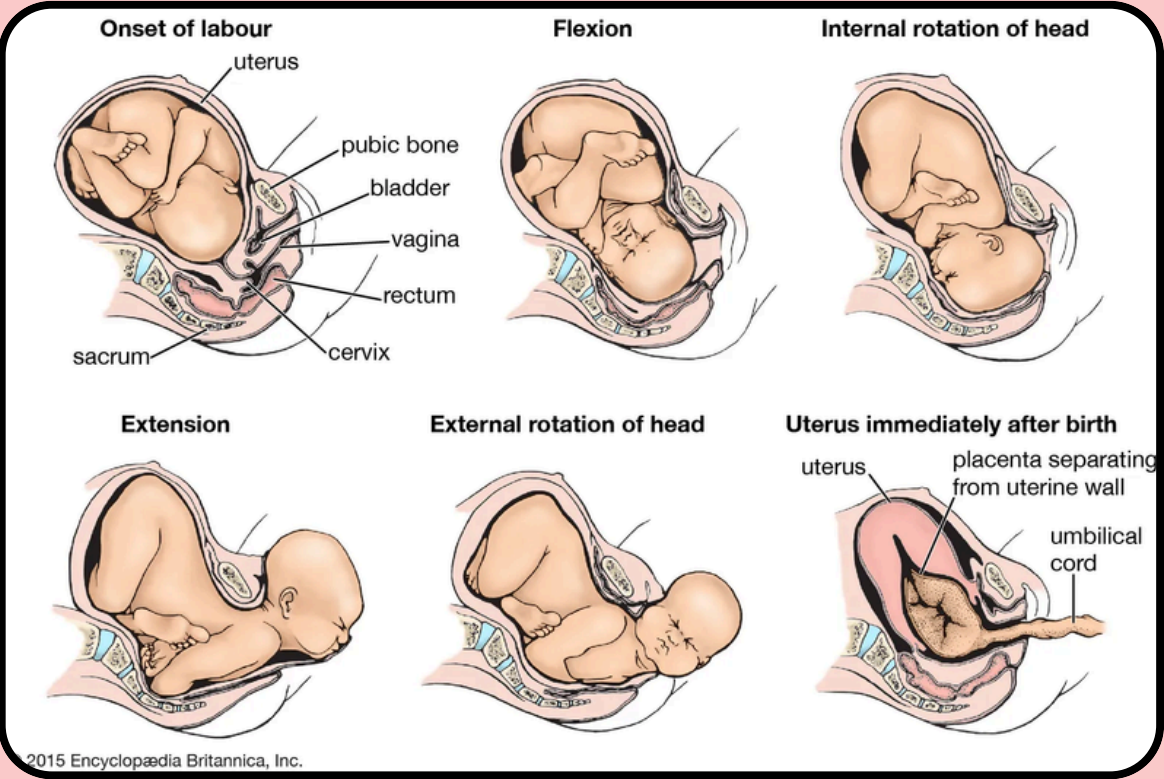
Doctor's Hands

Phase 2: Background Research

Learning Blender

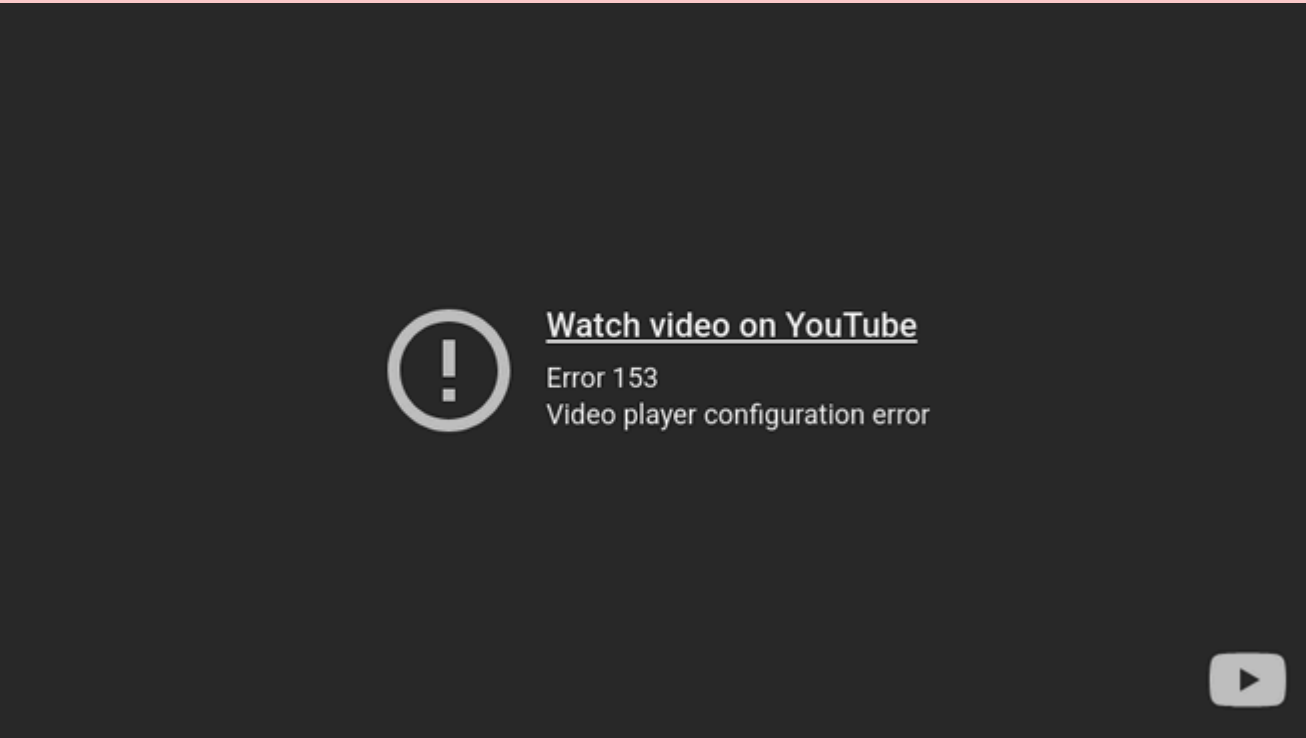


Learning the 7 Stages of Birth



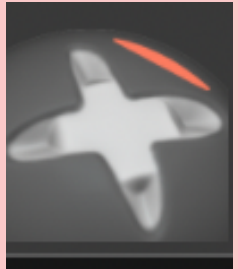
- 1. Engagement
- 2. Descent
- 3. Flexion
- 4. Internal rotation
- 5. Extension
- 6. External rotation
- 7. Expulsion

(Hutchison & Hutchison, 2023)



Phase 3: Sculpting

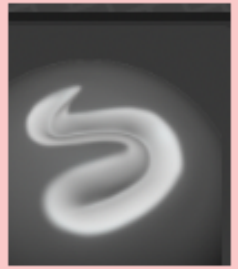
Tools Used:



Fill/Deepen



Grab



Draw Sharp



Smoothen

Before



After



Process:

To make the model **visually realistic** and for **defining joints** for rigging

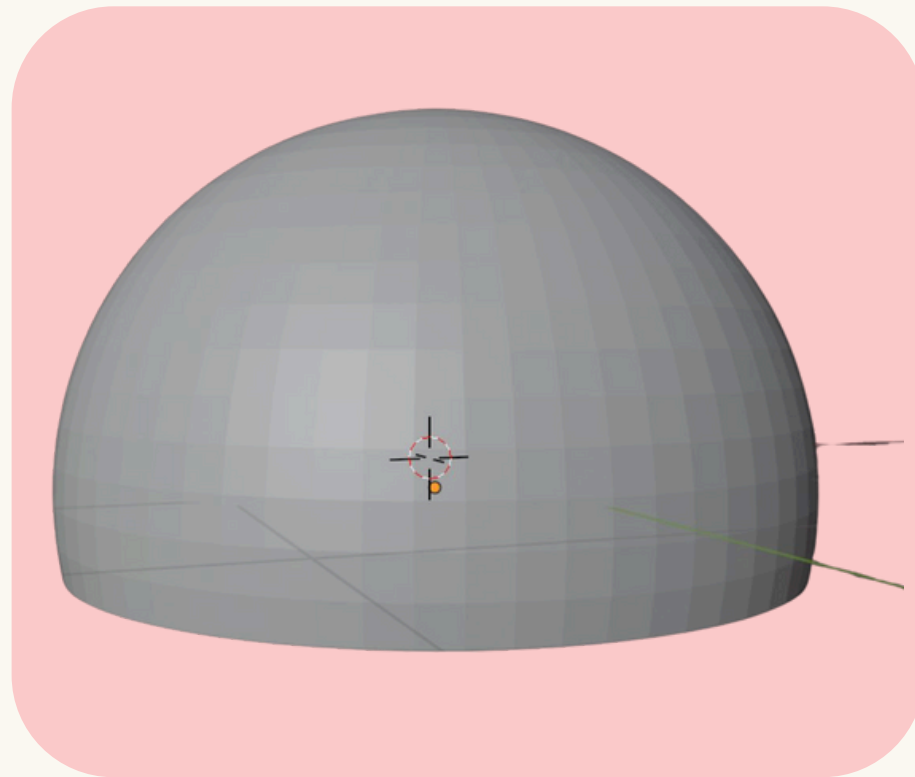
Intricate details lost in segmentation of MRI

Eyes and mouth were made using the deepen tool

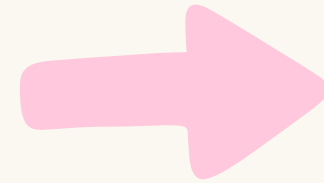
Fingers and toes made with draw sharp feature

Grab tool for the nose

Phase 3: Making of the Uterus



UV Sphere on blender



Uterus model

Tools Used:



**Solidify
Constraint**



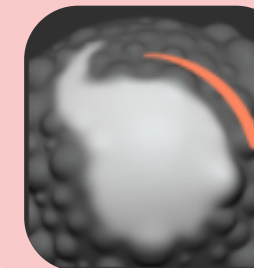
Knife Tool



Grab



Draw Sharp



Smoothen

Process:

Made from **UV Sphere**

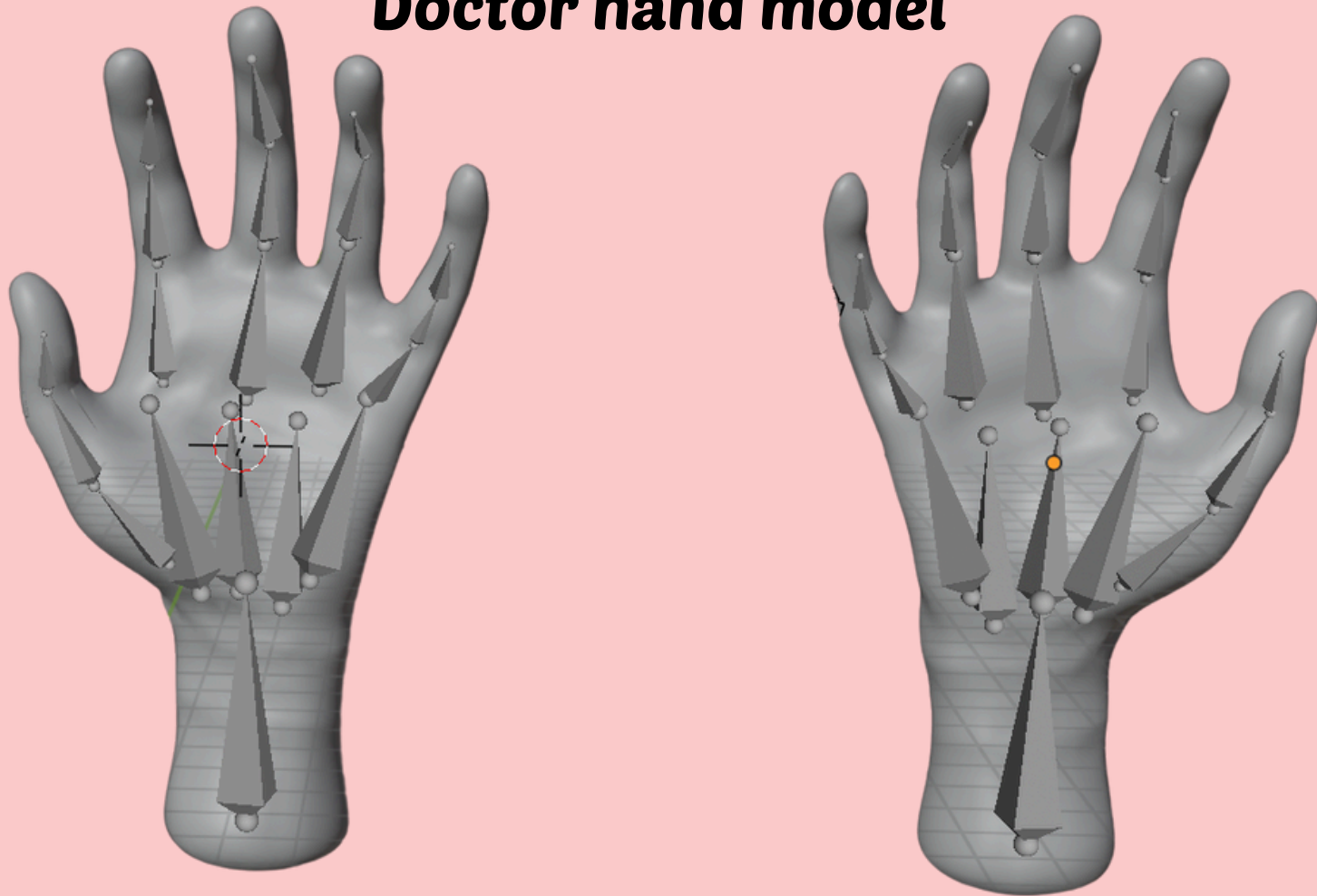
Sculpt mode -> Sculpted pregnant uterus shape and dilated cervix

Added **thickness** using **Solidify Modifier**

Cutting and creating cross-section with **knife & bisect tool**

Phase 3: The Doctor's Hands

Doctor hand model



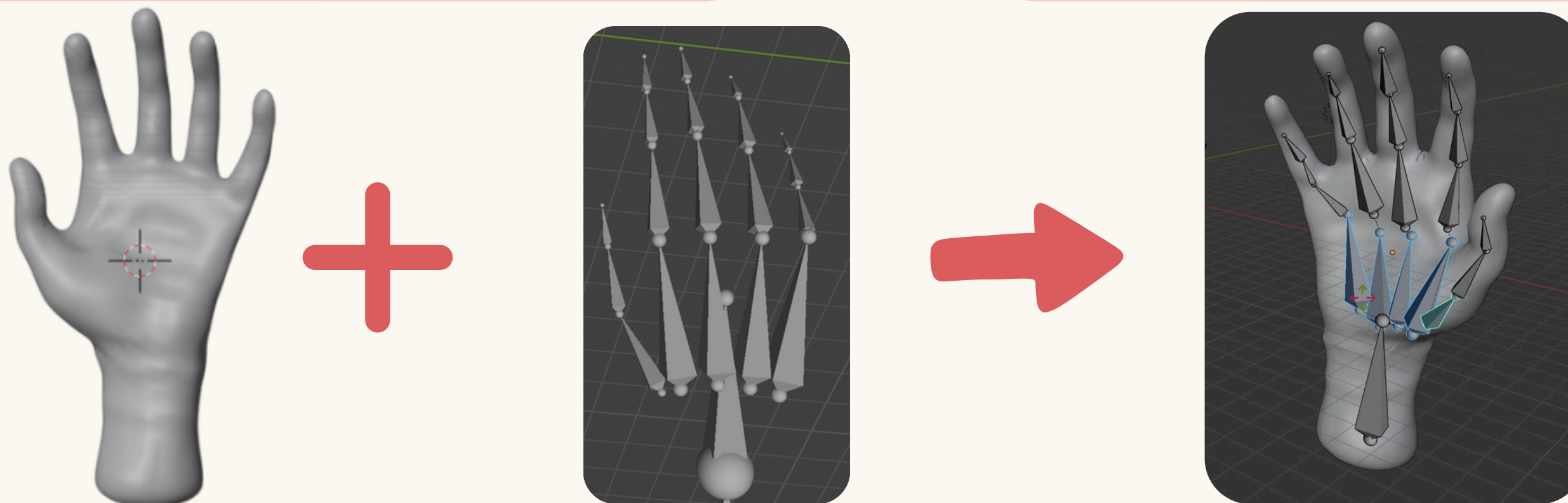
Process:

Sourced a **Pre-made** hand model with gloves from **Sketchfab**.

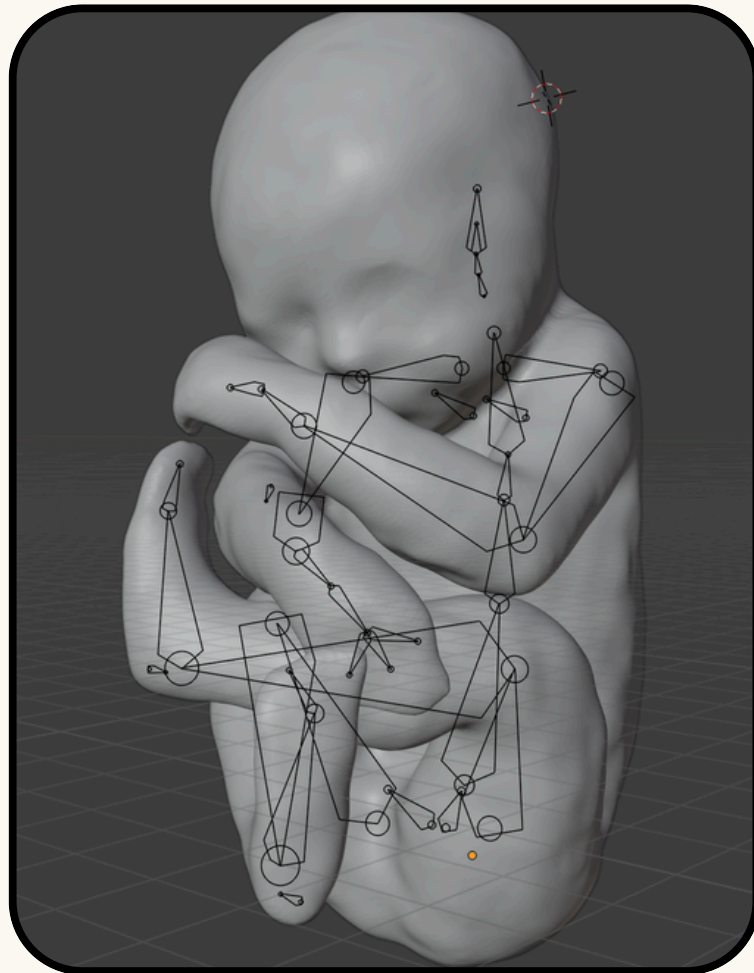
Rigged the model using **Rigify add-on**, using the **human meta rig** preset and **extracted** the hand bones from it

Required for **realistic** view of the **delivery process**

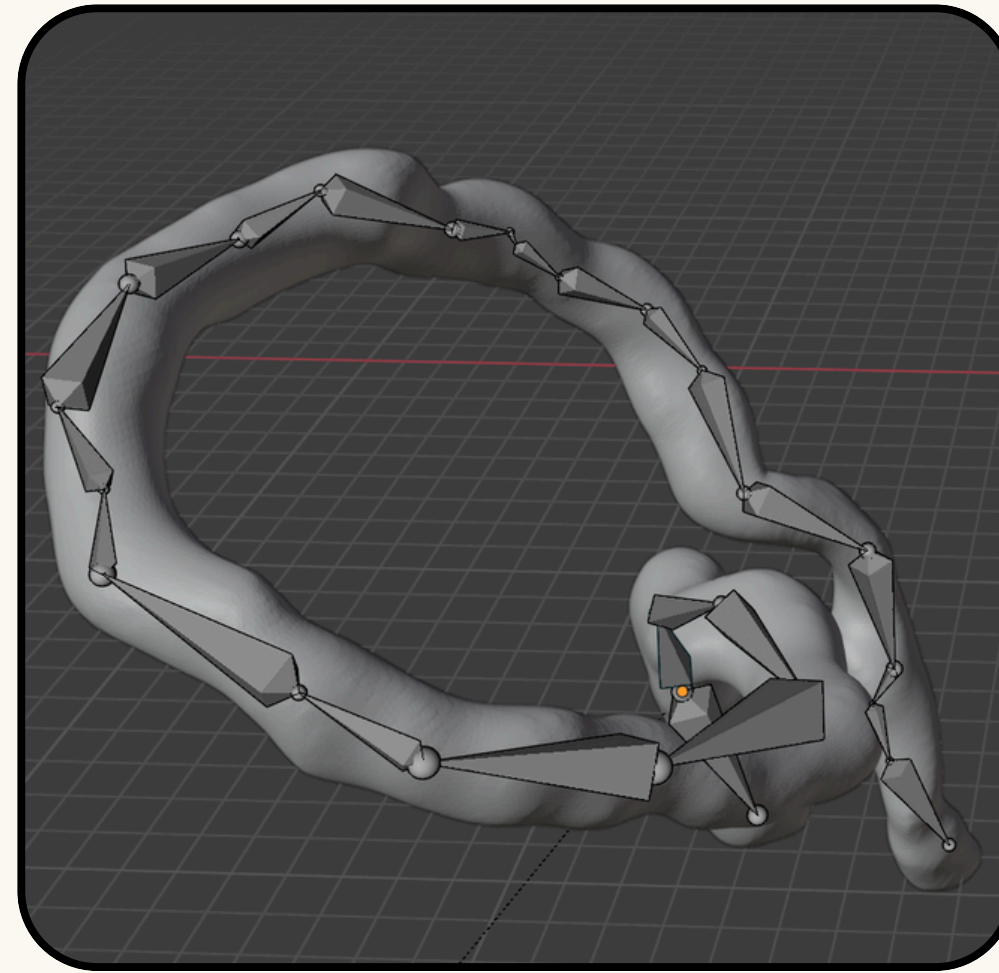
Rigging:



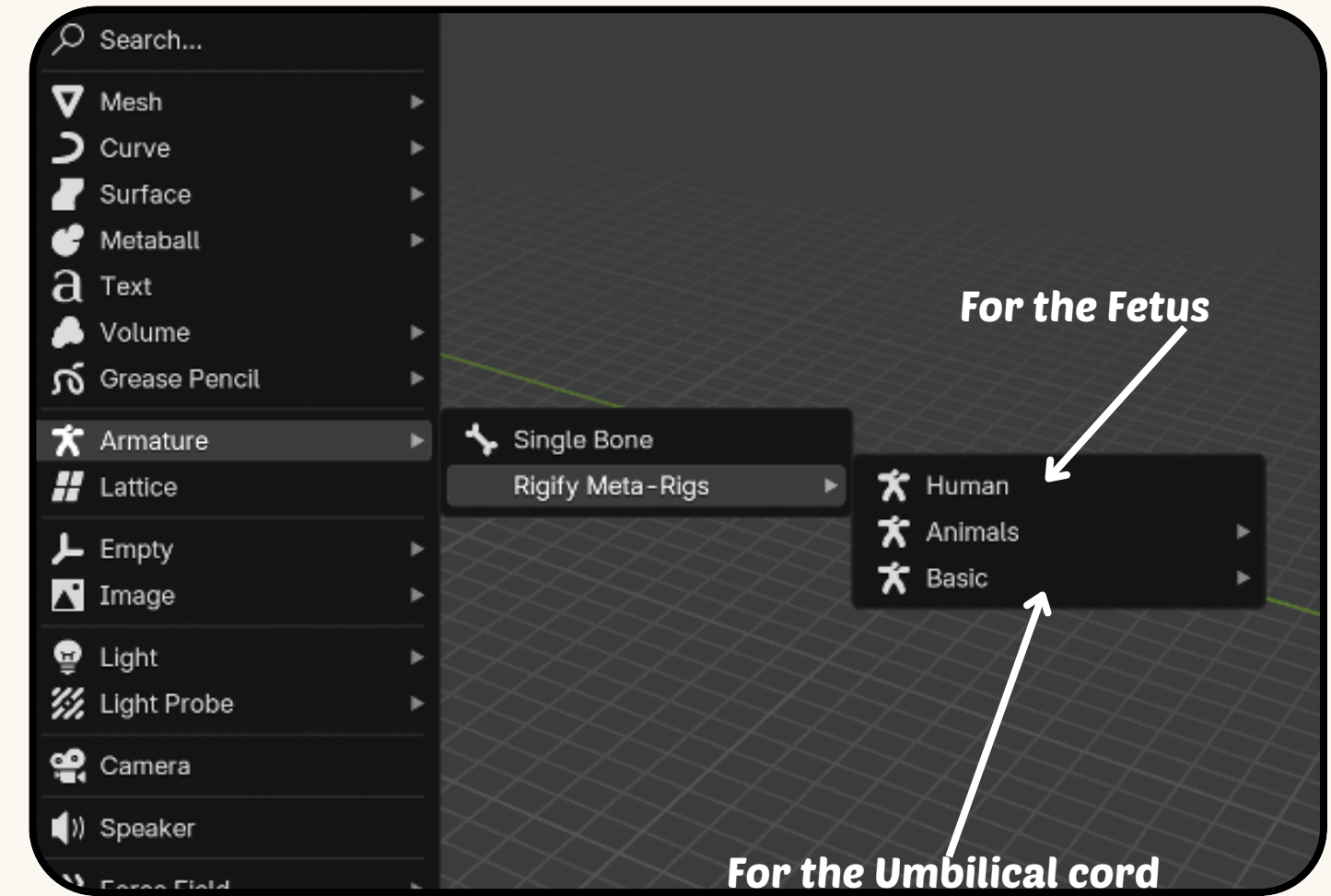
Phase 4: Rigging the fetus and the cord



Rigged Fetus



Rigged Umbilical Cord



Tool pathway to access pre-made bone armature

Process:

Used Rigify add-on for joint articulation in the fetus, modified to **fit fetal posture**.

Umbilical cord rigged with a **simple extruded bone chain**.

Applied weight painting to **control mesh deformation** and ensure realistic movement.

Rigging Process:

1. Add Metarig

Shift + A → Armature → Human (Rigify)

2. Fit to Model

Select armature → Tab (Edit Mode) → Adjust bones to match fetal pose

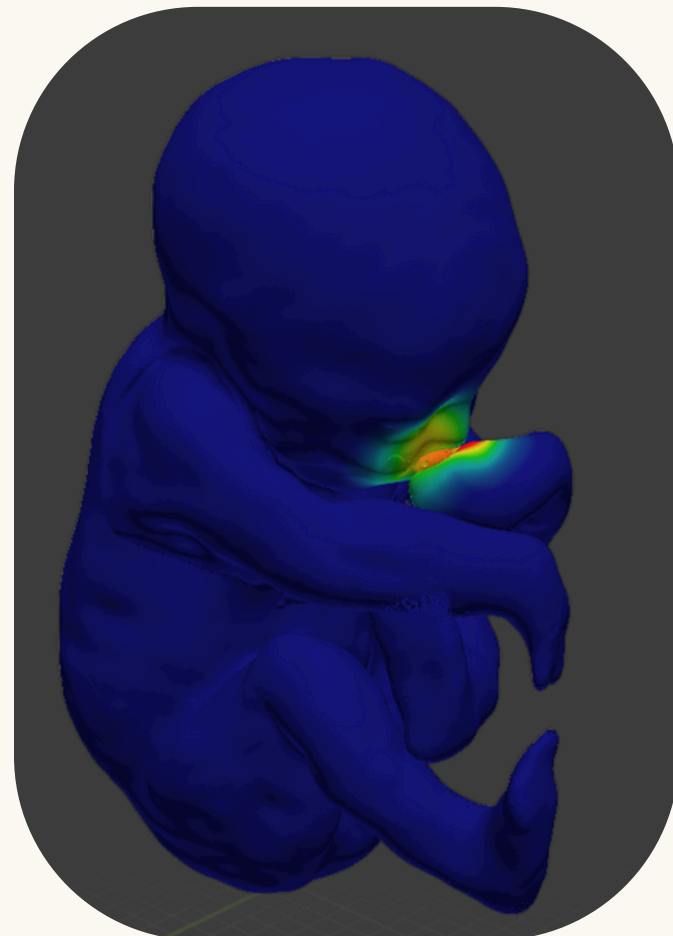
3. Parent Mesh

Select mesh → Shift + Click rig → Ctrl + P → With Automatic Weights

4. Test Rig

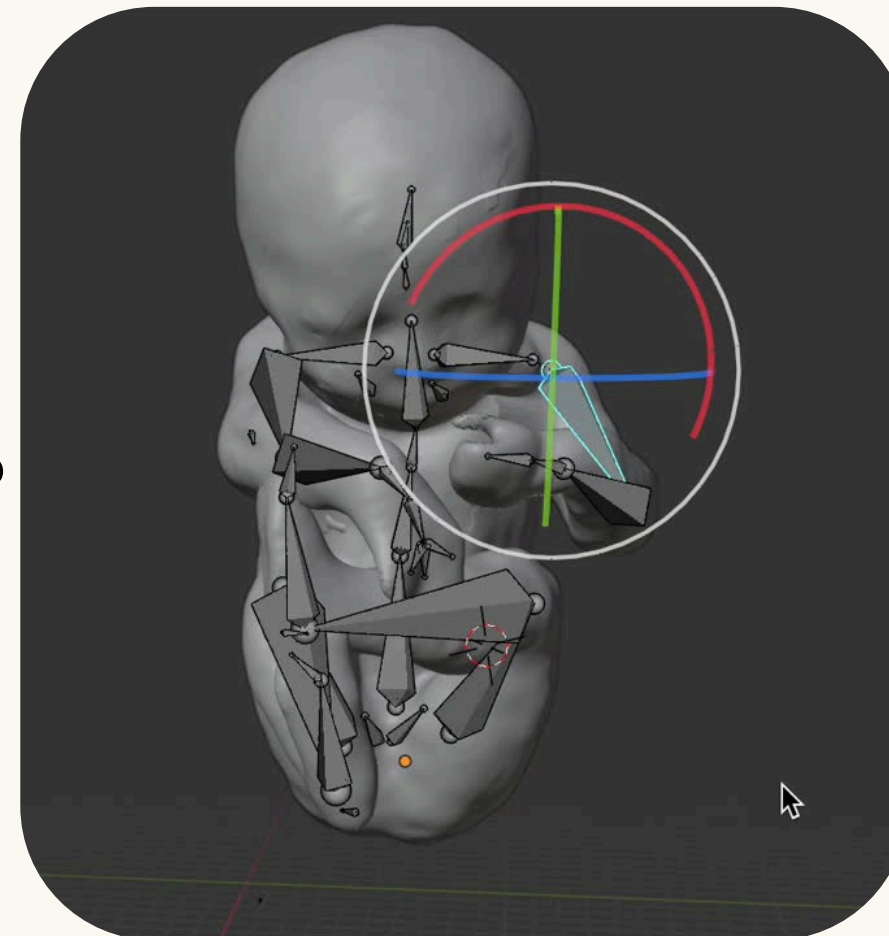
Pose Mode → Move bones → Check deformation

Challenge 1 : Incorrect weighting

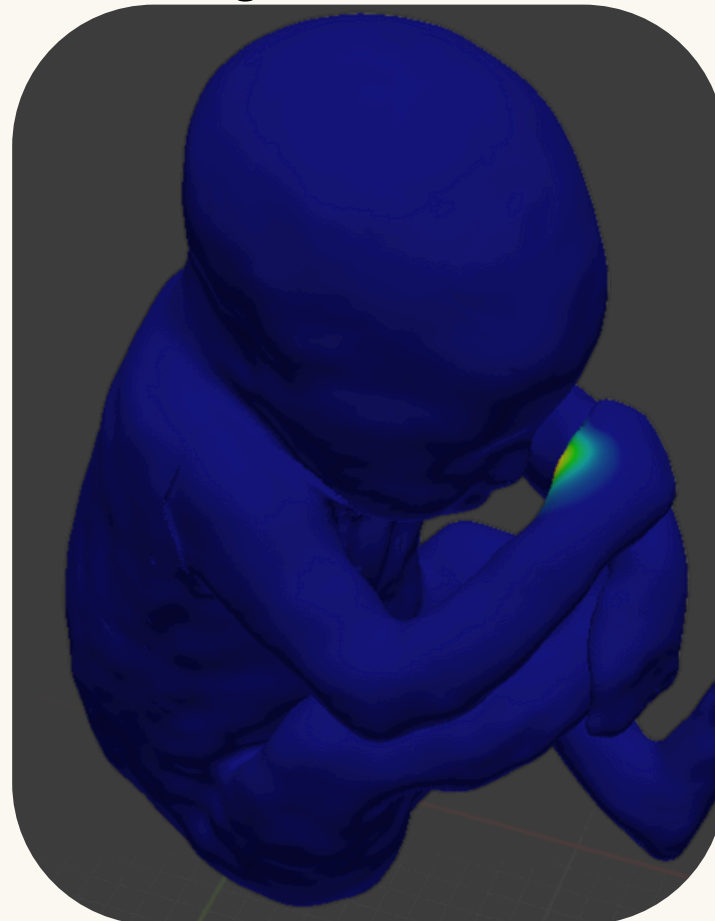
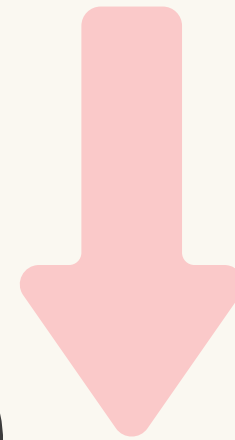


Weight Paint mode

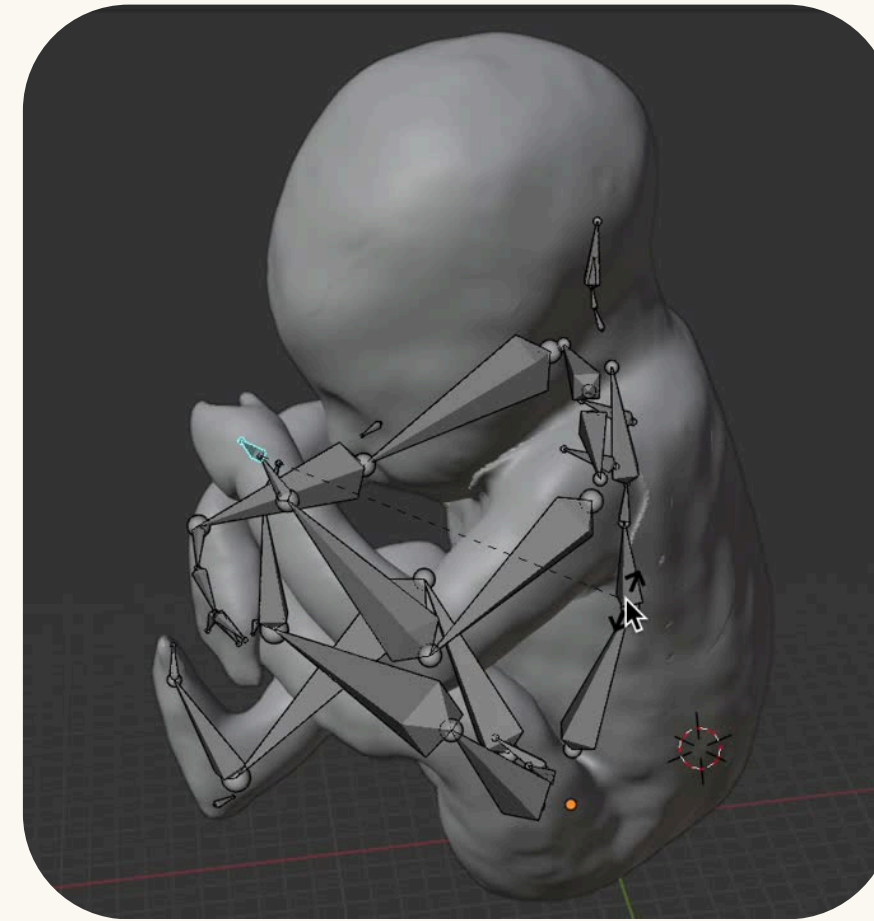
Before



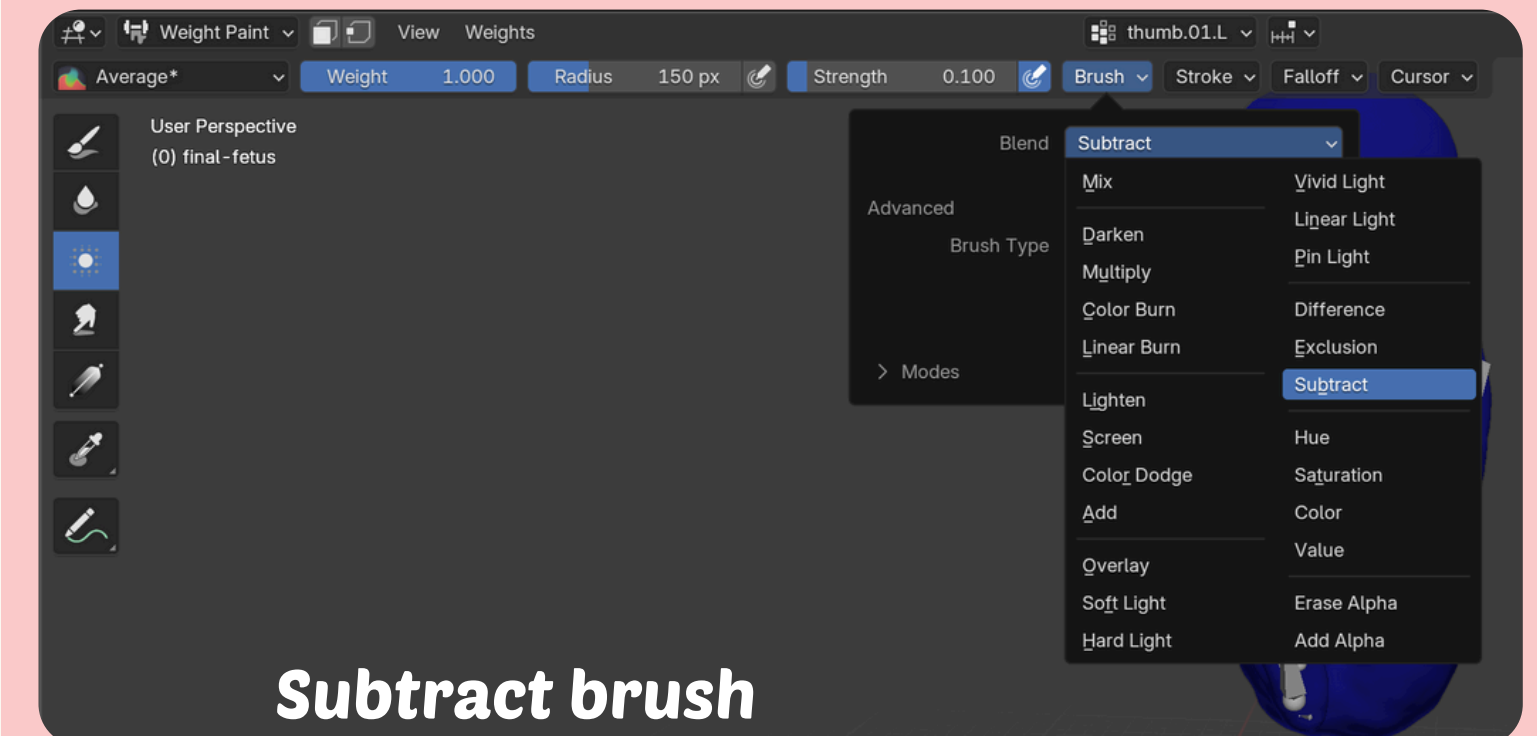
Pose mode



After

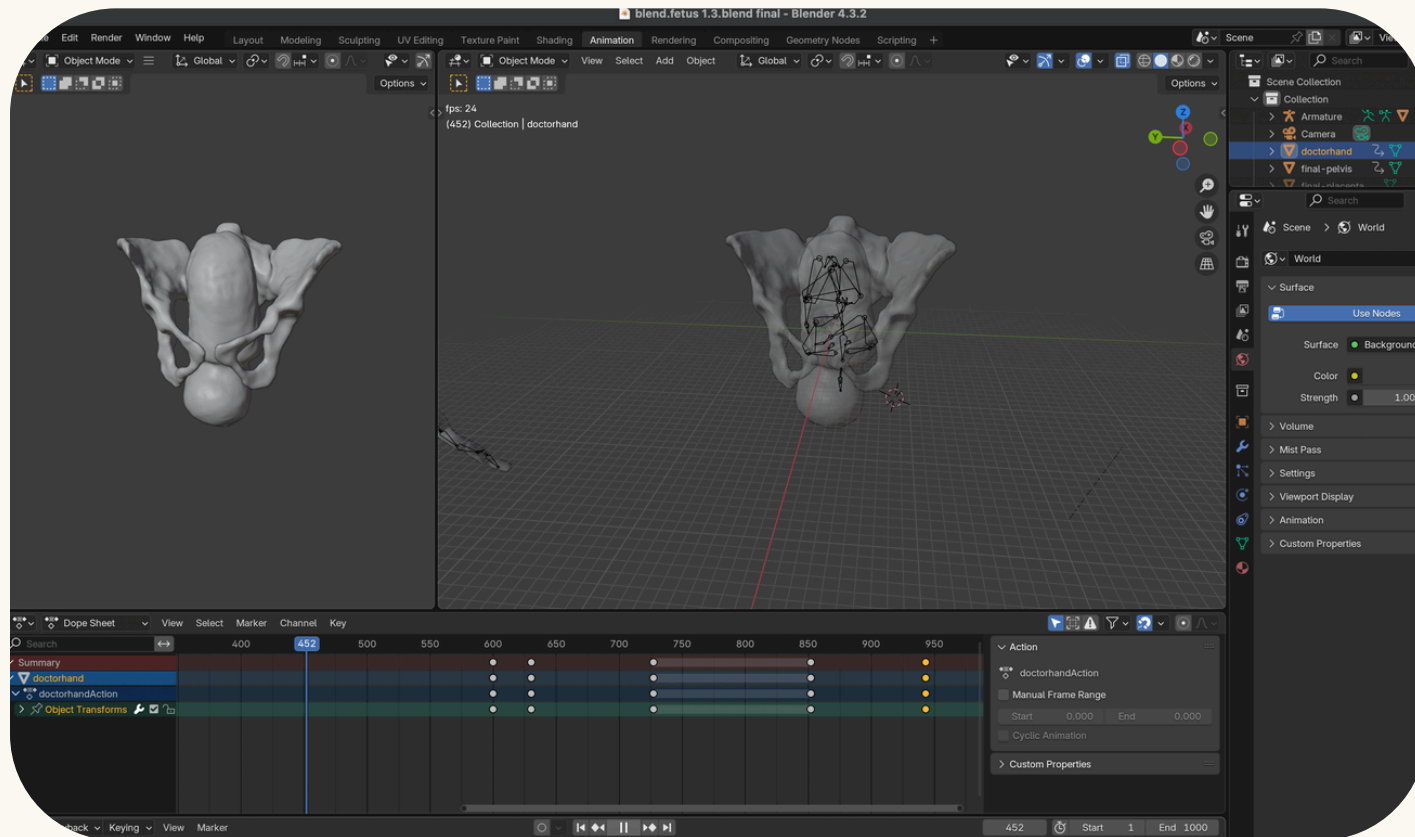


- The weights of certain bones of the fetus rig were incorrect
- **Problem**-> Thumb bone also controlled the face
- **Solution** -> Manually change the weight, of the bone in the thumb using weight paint subtract brush



Subtract brush

Phase 4: Animating the models



Animation Process:

1. Set Up Timeline

Adjust frame range to fit animation duration

2. Pose the Model

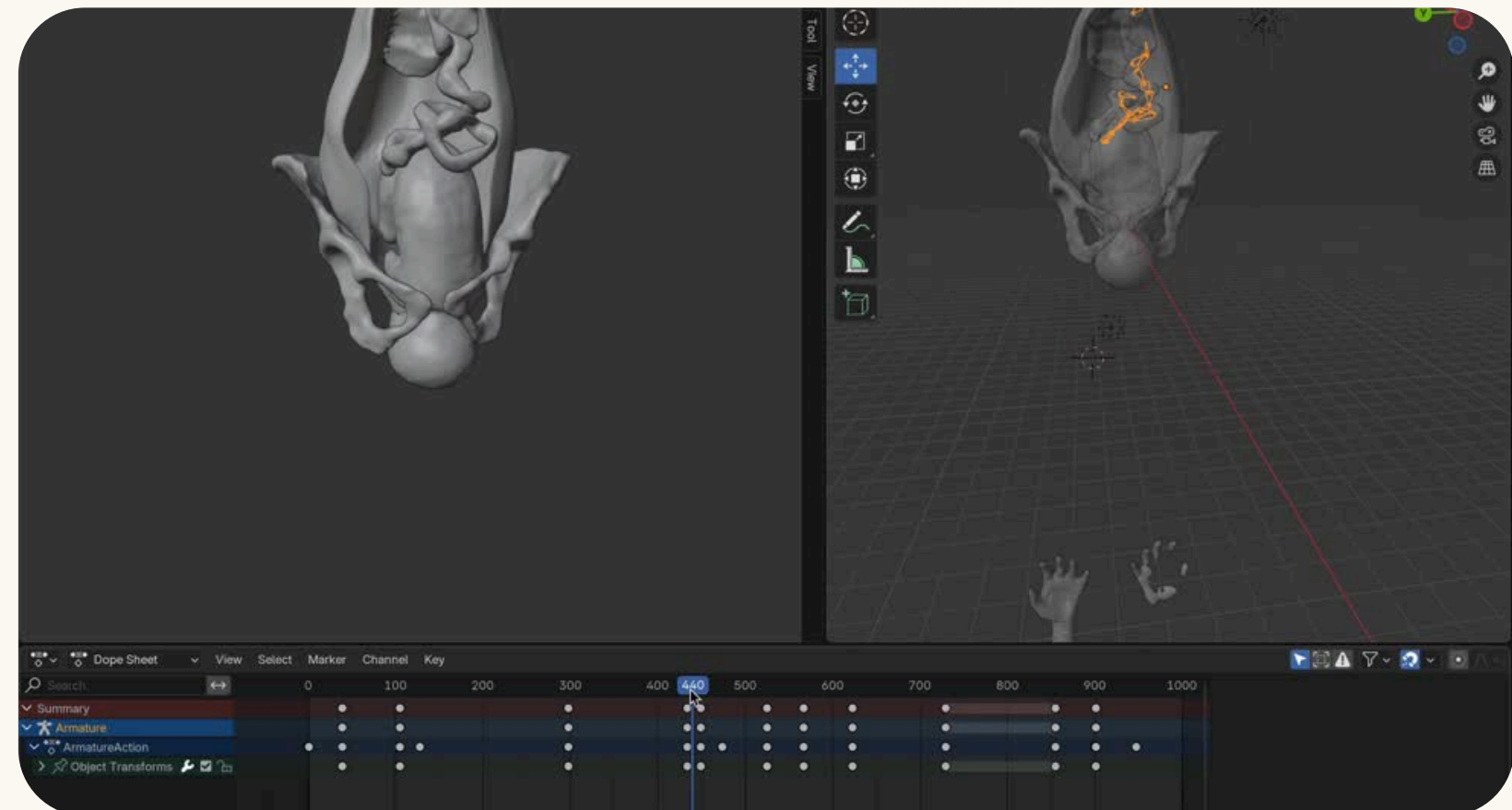
Select rig → Pose Mode → Position bones

3. Insert Keyframes

Press I → Choose “Location”, “Rotation” or “LocRotScale” at key frames

4. Advance Timeline

Move to next frame → adjust pose → insert new keyframe



5. Adjust Timing

Use Dope Sheet to space or shift keyframes for smooth transitions

6. Fine-Tune Poses

Tweak bone rotations/positions for realism (e.g. neck tilt)

7. Isolate Movement

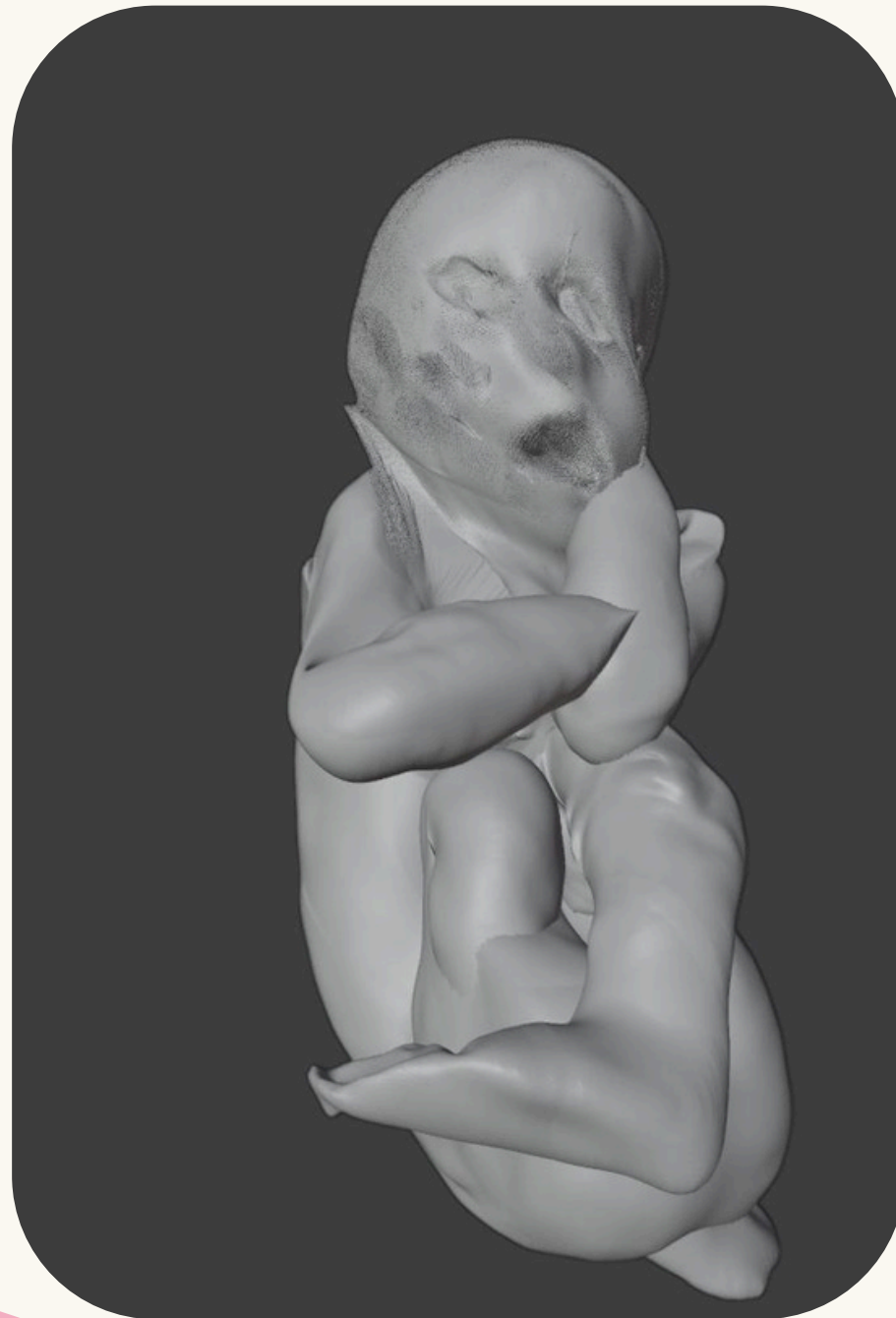
Lock or avoid keyframing bones that shouldn't move (e.g. spine stays stable)

8. Slow Down Motion

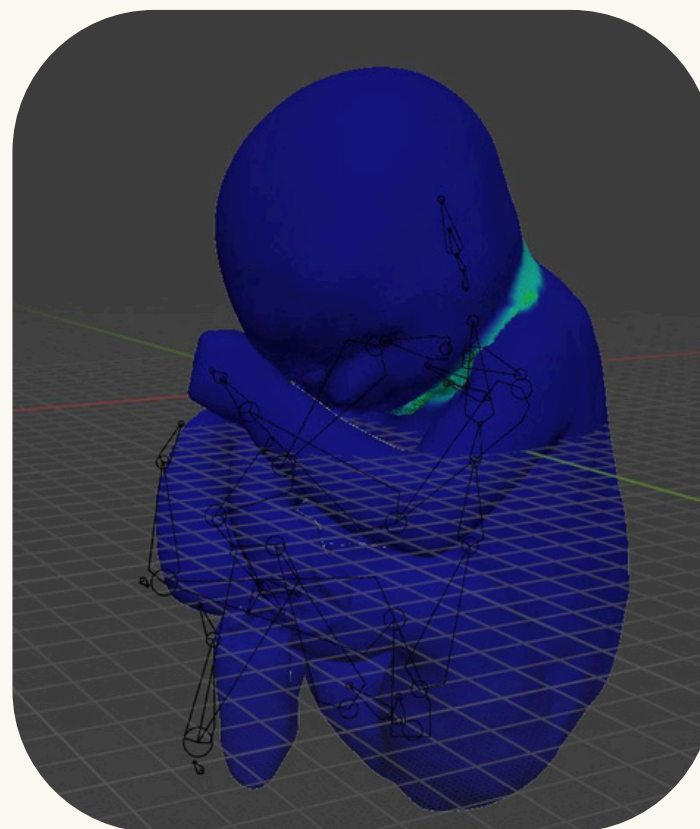
Add extra frames between key poses to slow movement (especially delivery stage)

Challenge 2: Deformation of the Fetus

Problem



Solution



Problem:

- The **fetus** model **deformed** during animation
- The neck was **tucked in**, so the rigged neck and head could not be **differentiated**.

Solution:

- **Created a neck** to separate the rigged structures
- Used **deflate tool** on the neck, and smoothen the surface
- **Added weights**



Smooth tool



Inflate/Deflate



Weight paint brush

Phase 5: Colouring and Rendering

Adding colour



Process:

1. Select Object

Click object in viewport or Outliner

2. Open Material Properties

Click red sphere icon in Properties panel

3. Create New Material

Click New → A default material will be assigned

4. Set Base Color

Change Base Color in Shader settings

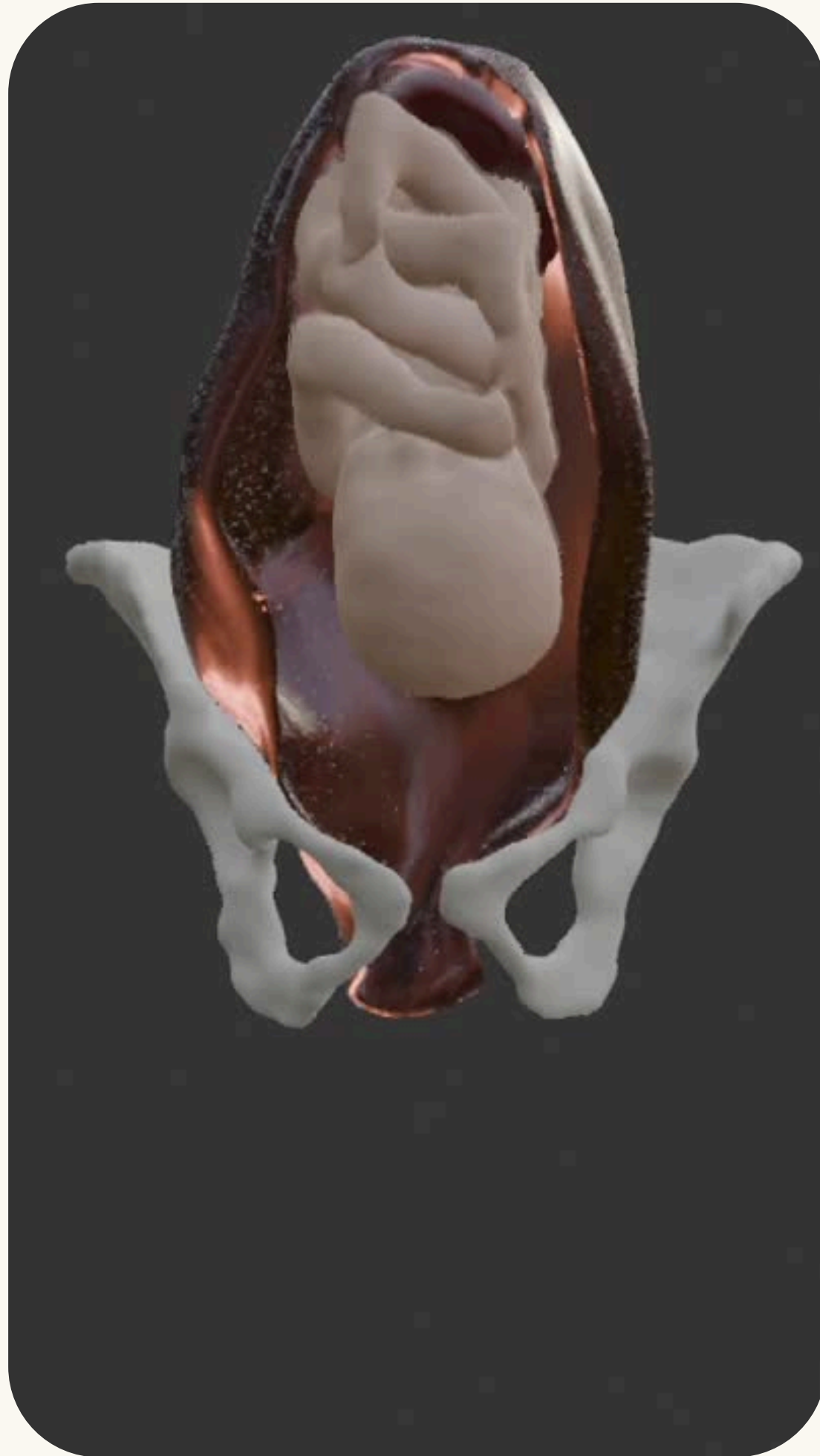
Rendering and Uploading to Looking Glass display

The animation included **over 1,000 keyframes** to capture the intricate fetal movements shown in the results, resulting in a **12-hour render time.**

After which it was uploaded on looking glass display



Looking Glass
Blocks



Included **anatomically accurate models** of the fetus, placenta, and pelvis, with the uterus and doctor's hand sourced or sculpted in Blender

- Successfully visualised the childbirth process using **patient-specific data**

Demonstrated potential to:

- **Educate parents** through clear visual explanation
- Support healthcare professionals in **identifying potential delivery risks**
- **Estimate labour duration** in future applications
- Holds strong potential for integration into the MiBirth platform

Reflection

Pros:

1. Equal Task distribution

Name	Contribution
Ana Sofia Henao Castro	Animation
Ritika Rajput	Animation
Michael Haddad	Sculpted uterus, material setup
Prithvish Ganguly	Model Rig creation, Sculpting presentation design
Arya Navab	Sculpting, presentation design

2. Chose Looking glass display over Meta quest 3

3. Successfully integrated patient-specific anatomy into a cohesive animation

4. Learned advanced Blender techniques under real constraints

Cons:

Technical Challenges

Faced multiple **hardware limitations**:

- Long render times (~**12 hrs**)
- Frequent **software crashes**
- **Loss of unsaved progress** due to Blender crashing under high loads

We were unable to create Childbirth animations in breach position and fetopelvic disproportion

References

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 Thank
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